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**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**  
(PCT Article 36 and Rule 70)



Applicant's or agent's file reference 8113127/PCT		<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/SG 03/00119	International filing date (day/month/year) 20.05.2003	Priority date (day/month/year) 03.06.2002	
International Patent Classification (IPC) or both national classification and IPC G12B21/02			
Applicant SENSFAB PTE LTD			

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet.  
  
☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:  
  

I	<input checked="" type="checkbox"/>	Basis of the opinion
II	<input type="checkbox"/>	Priority
III	<input type="checkbox"/>	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	<input type="checkbox"/>	Lack of unity of invention
V	<input checked="" type="checkbox"/>	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	<input type="checkbox"/>	Certain documents cited
VII	<input type="checkbox"/>	Certain defects in the international application
VIII	<input type="checkbox"/>	Certain observations on the international application

Date of submission of the demand  26.11.2003	Date of completion of this report  09.07.2004
Name and mailing address of the international preliminary examining authority:   European Patent Office - Gitschiner Str. 103 D-10958 Berlin Tel. +49 30 25901 - 0 Fax: +49 30 25901 - 840	Authorized Officer  Polesello, P  Telephone No. +49 30 25901-757  

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. **PCT/SG 03/00119**

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, Pages**

1-4 as originally filed  
5-6 received on 02.12.2003 with letter of 26.11.2003

**Claims, Numbers**

1-10 as originally filed

**Drawings, Sheets**

1/2-2/2 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).  
☐ the language of publication of the international application (under Rule 48.3(b)).  
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.  
☐ filed together with the international application in computer readable form.  
☐ furnished subsequently to this Authority in written form.  
☐ furnished subsequently to this Authority in computer readable form.  
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.  
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:  
☐ the claims, Nos.:  
☐ the drawings, sheets:

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Yes: Claims	1-10
	No: Claims	
Inventive step (IS)	Yes: Claims	1-10
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-10
	No: Claims	

**2. Citations and explanations**

**see separate sheet**

**Re Item V**

**Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

Reference is made to the following document:

D1: US-A-5 883 387 (MATSUYAMA KATSUHIRO ET AL) 16 March 1999 (1999-03-16)

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Document D1, which is considered to represent the most relevant state of the art, discloses (cf. figures 3A-3F) a method of forming atomic force microscope tips from which the subject-matter of claim 1 differs in that a pyramidal aperture (304 in figure 3B) is etched in the n-Si layer (301) after the p+-Si layer (303) has been deposited onto the n-Si layer and that a probe forming layer (305) is additionally deposited into the opening.  
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The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as to manufacture an atomic force microscope tip in silicon with good stiffness and few masking steps.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:  
etching the pyramidal aperture on the bare first layer of doped silicon allows to deposit a second layer of doped silicon onto the first layer so that a silicon tip is automatically formed in the aperture which is part of the second layer. Such a solution cannot be inferred from D1, where however a further deposition of another material is needed in order to form the probe (cf. figure 3C).

Claims 2-10 are dependent on claim 1 and as such also meet/s the requirements of the PCT with respect to novelty and inventive step.

Claims 1-10 satisfy the requirements of Article 33(4) as regards the industrial applicability.

and fills the apertures 3 formed by the KOH etching as shown in Figure 1C. The layer of epitaxial silicon is doped to have the opposite doping of the first layer of silicon. For example if the first layer of silicon is p-type doped then the layer of epitaxial silicon is n-type doped and if the first layer of silicon is n-type doped then the layer of epitaxial silicon is p-type doped.

Figure 1D shows the results of an anisotropic etch. This etch forms troughs and raised areas in the epitaxial silicon layer 4. In Figure 1E a second layer of silicon has been fusion bonded to the layer of epitaxial silicon. This forms cavities 8 between the two layers. Ideally the second layer of silicon has the same doping as the layer of epitaxial silicon.

Following the bonding of the two layers of silicon the first layer of silicon 1 is removed by electrochemical etch. Because the first layer of silicon and the epitaxial layer of silicon 4 are doped differently the boundary between the two layers forms a diode junction. This diode junctions acts as a stop for the electrochemical etch. This allows the first layer of silicon 1 to be removed leaving the tips formed in the layer of epitaxial silicon 4 and solves the problems of removing the tips from the mould.

Figure 1F shows the layer of epitaxial silicon 4 with cavity 8 after removal of the first layer of silicon. A masking layer 5 is deposited onto the epitaxial silicon 4. The masking layer 5 covers the atomic force microscope tips but is deposited to leave a gap 6 after each tip.

Figure 1G shows the results of a release etch. This etches away the epitaxial silicon not covered by masking layer 5. This releases the tip from the nearest raised layer of epitaxial silicon 4 and leaves the tip cantilevered. Finally the masking layer 5 is removed to leave the cantilevered atomic force microscope tips.

Other process steps can be added to this process to form other MEMS structures such as actuators or features such as metal interconnects/bondpads.

In another embodiment the steps illustrated in Figures 1D to 1G are omitted and the first layer of silicon 1 is removed by electrochemical etch after the step of depositing the layer

REPLACEMENT SHEET

AMENDED SHEET

of epitaxial silicon 4 shown in Figure 1C. In this embodiment the atomic force microscope tips formed using the method of the invention are not cantilevered. Again further steps can be added to this process to form other MEMS structures or other features.

- 5 Using the method of the invention atomic force microscope tips have been produced with a base of  $4 \times 4$  microns and height of 2.82 microns. The tips produced using the method of the invention are formed of silicon and have superior stiffness and strength to tips formed of other materials such as silicon nitride, silicon dioxide etc. Atomic force microscope tips formed using the method of the invention are more uniform than those formed using
- 10 chemical vapour deposition.

The foregoing describes the invention including preferred forms thereof. Alterations and modifications as will be obvious to those skilled in the art are intended to be incorporated within the scope hereof as defined in the accompanying claims.

**REPLACEMENT SHEET**

AMENDED SHEET